Pulse Oximetry: A Review, with Emphasis on Applications in Dentistry

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Oximetry, the measurement of oxygen bound to hemoglobin (Hb), is a relatively recent advance in anesthetic technology. The devices measure the ratio of oxyhemoglobin (Hb_O to total Hb, relying on the different patterns of light absorption characteristic of Hb_O and reduced Hb). Hb_O absorbs strongly in the red zone, where Hb has a low specific absorption coefficient; the situation is reversed in the infrared range.

Pulse oximetry is a non-invasive method that takes advantage of this absorption coefficient difference to monitor O_2 saturation and pulse rate with a single sensor placed on the patient's extremity,[1] and a plethysmograph to measure arterial oxygen saturation in a pulsating vascular bed such as that of a finger.[2] By using the two wavelengths, the difference between Hb and Hb_O concentrations can be calculated.[4] The expansion and relaxation of the pulsating vascular bed creates a change in the length of the light path modifying the amount of light detected.[4] The laws of physics governing the change have been explained by Dean *et al.*,[5] and it has been established that venous blood does not interfere.[6]

The Instrument

The pulse oximeter contains two light emitting diodes (LEDs) mounted in opposition to the photodetector. Light of the two wavelengths 660 nm (red) and 925 nm (infrared) is emitted from the LEDs to pass through the tissue and thence to the photodetector. The signal passes to a microprocessor, where only pulsatile signals are used to calculate oxygen saturation. The transmitted light is converted into a digital display of both arterial O_2 saturation and pulse rate. No heating or arterialization of the site is needed, and absence of a requirement for prior calibration is an advantage.[7]

Use of the pulse oximeter is relatively simple. The measurement of arterial O_2 saturation with this instrument is almost completely independent of the patient's age, physical status[8] and skin pigmentation; the latter characteristic makes it particularly useful in black patients in whom visual assessment of cyanosis often is difficult.[9] The devices are easily portable.

The most significant disadvantage of the device lies in the fact that it does not register significant changes in arterial oxygen tension until the P_aO_2 reaches 60 to 70 mm Hg. As P_aO_2 decreases from 500 mm Hg to 70 mm Hg, no useful trend information can be obtained with the instrument. P_aO_2 can be predicted from the per cent saturation through the oxygen-hemoglobin dissociation curve, however. Other major limitations of the pulse oximeter are its sensitivity to motion and the requirement for a pulse. Finally, calibration of the instrument is purely empirical and cannot be checked.

Use in Dentistry

Beeby and Thurlow evaluated the Nellcor N-100 pulse oximeter in a dental outpatient clinic in 30 children requiring tooth extractions under general anesthesia;[9] the device was beneficial in 25 of the 30. Excessive movement following insertion of an intravenous line precluded collection of data until anesthesia was well established in four children. The device provided early warning of airway obstruction before that had been recognized clinically by the anesthetist. Mueller *et al.* used the device in 40 healthy children who were sedated while undergoing extractions or operative procedures.[4] Their data suggest that significant periods of oxygen desaturation may occur in sedated children without predictable changes in the patients' vital signs. Hypoxemia is recognized as a major complication of sedation in children. Monitoring to detect early signs of hypoxemia before deleterious manifestations of respiratory depression occur is essential. Mueller found pulse oximetry to be "more sensitive to hypoxemic changes than measurements of heart rate, blood pressure, respiratory rate or visual observation of cyanosis in sedated pediatric dental patients."

The pulse oximeter may prove useful as well in medically compromised patients. Oral surgeons, periodontists and others who use conscious sedation techniques may find this form of monitoring of benefit.

Increased monitoring is widely advocated.[10] The future of the pulse oximeter has been predicted by

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Severinghaus and Astrup: "Pulse oximetry is arguably the most significant technological advance ever made in monitoring the well-being and safety of patients during anesthesia, recovery and critical care."[11]

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